Communications & Electronics Division

Motorola NEWSGRAM

Nov-Dec, 1952

Power Utility Issue

from MOTOROLA *Management* . . .

Communications & Electronics Division

From left to right: John F. Silver, General Manager; John F. Byrne, Director of Engineering; Arthur L. Reese, Marketing Manager, Microwave, Carrier and Control; Myron E. Whitney, Marketing Manager, Mobile Services; Harold A. Jones, Manager, Technical Information Center.

Motorola's Communications and Electronics Division extends to all its NEWSGRAM friends sincerest year end greetings. We hope that this Motorola service, "The NEWSGRAM", has enjoyed a significant position on your regular reading list. It is designed to insure better communications—Motorola's specialty.

The past year has granted the industry invaluable experience in adjacent channel operation and has brought us to the era of split-channels. With the SENSICON circuit, PERMAKAY Filter and I.D.C., Motorola has successfully tested and commercially operated split channel equipment.

Additional channels are practicably available with the advent of fully matured and tested 450-470 mc. equipment. Now mobile 2-way radio is licensable to many who, under F.C.C. rules, were previously unqualified. The year 1952 found Motorola the first and only radio manufacturer with 460 mc. Class A Citizens Band F.C.C. type approval—another Motorola first.

Microwave relay loomed large over the horizon in 1952 with many cross country systems proving themselves during that period while many other installations were completed and operations initiated. To date, Motorola has designed and installed over 70% of the privately owned microwave systems in and operating in the U.S. Similarly tremendous strides have been made in the power line carrier and supervisory control fields.

With this brief year end message, Motorola assures all communications users that our research laboratory, our plant facilities, our engineering talent, our 24 years of experience and our entire basic policy are dedicated to the advancement of the communications and electronics art in order that we may produce better communications equipment for the best possible service to our customers.

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and from the NEWSGRAM *staff* . . .

With this issue of the Newsgram we conclude the 1952 volume. From all reports coming into the NEWSGRAM office the magazine is well received and enjoyed by all readers. The staff invites comments of all Newsgram subscribers in order that we may bring to you an even better publication in 1953.

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The

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and

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A. A. A. DEMONSTRATES 450-470 Mc. SYSTEM

Observers at AAA showing of Motorola 450 Mc. system are: (in car) Douglas Anello, FCC Safety & Special Services; and (left to right) Col. Edwin L. White, Chief, FCC Safety and Special Services; Harriss Robinson, Motorola; Wilson Switzer, Radio Communications Service; Leverne Johnson, Washington Mgr., AAA; Fred Roberts, Phelps-Roberts Corp.; Gus Preno, Phila. Mgr., AAA; Jeremiah Courtney, AAA attorney; William Watkins, FCC Safety and Special Services; James Reardon, Director, National Automotive Service, AAA; Ken Graham, Motorola; James Simon, Washington Div., AAA; Fred Shaw, Pa. Bell Tel. Co.; W. E. Darnell, Pa. Bell Tel. Co.; Robert Tall, Assoc. Editor, Mobile Safety Radio Reports.

One of the first Motorola 450-470 Mc. two-way radio systems to be installed was recently demonstrated in Washington, D. C., by the American Automobile Association. The demonstration was observed by representatives of the FCC, Pennsylvania Bell Telephone Company, the Philadelphia Division of the AAA and Motorola, Inc.

The system's base station transmitter is installed in a weatherproof cabinet on top of the Skyline Towers Building, a 100 foot building near the intersection of Wisconsin and Massachusetts Avenues in Northwest Washington. The building is located on high terrain, consequently coverage is exceptionally good.

For the demonstration, the car was driven over Northwest Washington and into Maryland. Two-way communication was maintained over the entire area, more than adequate for the AAA's purposes. The car was also driven along the steep banks of the Potomac River into Virginia with no dead spots noted.

The system performed perfectly in all phases of the demonstration. Especially noticeable was the complete absence of ignition noise. In one instance, the test car was driven into a sub-basement three floors underground, yet operation of the 450-470 Mc. system was excellent.

The complete absence of electrical interference plus the highly desirable propagation characteristics for urban areas point toward a tremendous growth in UHF radio usage.

Conventions

IRE . . . .

Motorola Vice President Daniel E. Noble highlighted the December 3rd meeting in Washington, D. C., of the Professional Group For Vehicular Communications with his talk on adaption of Motorola two-way radio for split channel operation to alleviate band crowding. The discussion was given substance by reference to the year-old, split channel MCC system in Phoenix over which excellent results have been achieved.

A display at the convention aptly illustrated the few simply effected changes required to adapt a Motorola unit for such operation.

Motorola used an actual commercial installation to demonstrate its new line of 450-470 Mc. equipment. The demonstration of this system was made possible through the courtesy of James Reardon, national automotive service director of the American Automobile Association.

The system demonstration followed Mr. Noble's announcement that Motorola is the first and at the present time the only manufacturer to have specific FCC equipment type approval for Class A Citizen's Band operation.

POWER . . . .

New advancements in the power utility communications field were presented at a recent meeting in Dallas, Texas between management representatives and engineering personnel of power utilities and engineers of Motorola's Communications and Electronics Division. This Power Utility Communications Symposium was one of a series of similar meetings being held throughout the country.

The Motorola staff, headed by Vice President Daniel E. Noble, led discussions on the application of microwave, power line carrier and supervisory control systems in the power utility industry. Microwave and power line carrier systems are rapidly gaining industry wide acceptance as the power utility communications media. Both systems operate on a point-to-point basis. Each system is capable of transmitting several signals simultaneously, including voice, teletype, telemetering and supervisory control information.

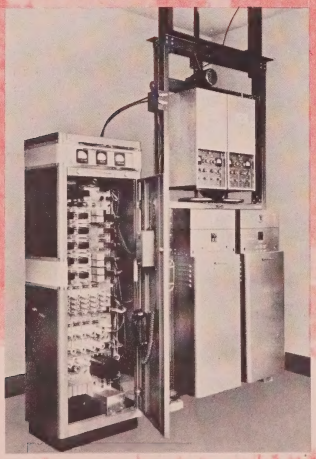
A recent development discussed at the meeting was Motorola's Vibracode System, a method of supervisory control rapidly gaining favor among the power utilities.

P. P. & L. finds....

MICROWAVE MANDATORY

Across the nation, the power industry is expanding to meet the ever increasing domestic and commercial demands upon its resources. In the Pacific Northwest, the Pacific Power & Light Company has made its contribution to the national program by constructing two hydro-electric plants on the Lewis River in the Rocky Mountains of Southwest Washington.

A large scale construction job such as that undertaken by Pacific Power & Light poses many seemingly insolvable problems. One of the most interesting of the problems encountered in the completion of the P. P. & L. project was in the setting up of communication facilities between Merwin and Yale, sites of the two dams.



This microwave equipment is installed at the Merwin Dam power station. The multiplexing chassis are contained in the cabinet with the open door. The identical main and standby RF installations are to the right, directly under the roof-mounted antenna dish.

Conditions imposed by both man and nature dictated the selection of the communication medium. The requirement of one control and four voice channels made VHF impractical. High cost and irregular terrain eliminated telephone lines. At certain times of the year the remote and rugged country between Yale and Merwin is virtually impenetrable. If a break in the lines rendered one or more channels inoperative during one of these periods, maintenance crews might be stymied for days, an unthinkable situation from the standpoint of P. P. & L. The obvious solution on the basis of comparative economy and absolute dependability was multi-channel microwave.

ANOTHER PROBLEM

However, one tremendous obstacle remained. A mountain sat squarely between the two power stations. The logical line-of-sight signal path at one point passed 1,800 feet underground.

One possible answer was to locate one of the microwave towers some distance away from its associated power station so the signal path passed around the mountain. The objection to this solution was that the microwave station would have to be fed by power and signal lines as vulnerable as telephone lines.

The use of an unattended relay station was obviated for the same reason. Such a system would require that power lines be strung or fuel hauled to the intermediate station over the sometimes impenetrable terrain.

The final solution was the installation between the two stations of a passive repeater, so placed and oriented that the signal passes around the mountain over a two-legged path.

The reflector was constructed so sturdily that destruction or even misalignment from natural causes is no source of concern. There also is no possibility of structural weakness resulting from corrosion as the reflector is made of aluminum. Of course, no power is required at the reflector.

The signal attenuation attributable to the inclusion of the reflector in the signal path is only 7 db. In view of the more than ample fading margin of 33 db. designed into Motorola microwave equipment, the loss of 7 db. is negligible.

As indicated in the Microwave Channel Allocation Chart, one of the five voice channels is used for transmission of supervisory control signals, telemetering, and actuation of protective relays. Another is a manually switched standby channel for the first, to be utilized on the rare occasions when the primary channel is out of service. Two other channels are used for local telephone service, one connecting a telephone in the Merwin control room to the private automatic exchange at Yale and the other connecting a telephone in the Yale powerhouse to a cordless switchboard in the Merwin control room. The fifth channel connects a total of seven telephones, one in the Yale powerhouse and one in each of the operator's houses at Yale, on a party line basis over a wire line from Merwin to the manual switchboard of the Woodland Telephone Company, which is interconnected with the Bell System. Thus, these people in a relatively isolated section of the country are able to talk to the

Two members of Motorola's engineering staff, Henry Magnuski and Ted Koch, have recently written an enlightening treatise to be printed in a forthcoming issue of ELECTRONICS Magazine. The article discusses the factors governing the use of the passive repeater with special reference to the Pacific Power & Light installation. Readers are also referred to the photographs of the P. P. & L. system which appear on pages 16 and 17 of this magazine.

nearest town or across the country through telephone service extended by commercial microwave.

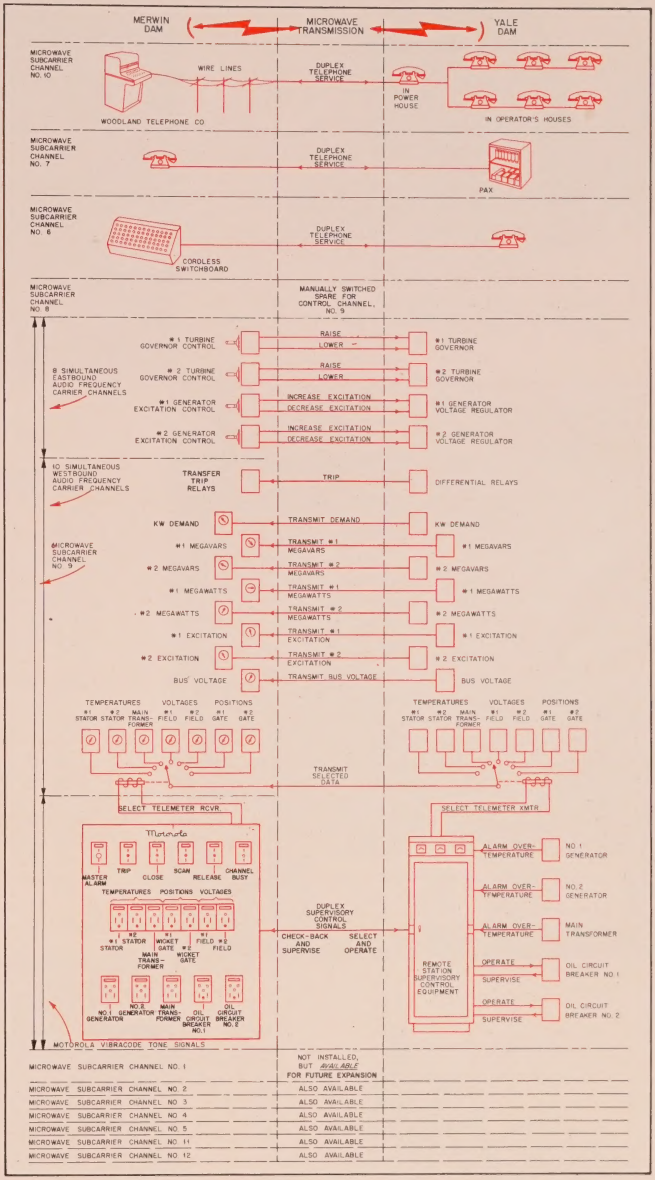
CHANNEL 9

Channel 9 is very efficiently utilized. The channel is divided into eighteen sub-channels by Motorola Audio Frequency Carrier equipment. Still another subchannel is effectively added by the use of microwave channel for the transmission of the duplex supervisory control signals.

Six points are controlled by the Motorola Supervisory System, and provision is made for the addition of several more.

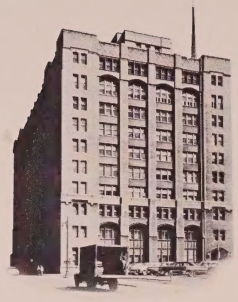
One audio frequency carrier sub-channel is used to transmit telemeter signals from whichever of the seven possible telemeter transmitters may have been selected through the supervisory control equipment. Eight other audio frequency carrier sub-channels continuously carry telemetering information. Another one is used to make operation of a circuit breaker at Merwin dependent upon load conditions at Yale. The last eight are used in pairs to remotely control from Merwin four incremental adjustments of equipment at Yale. The information upon which the adjustments are based is supplied by the continuously operating telemeters.

The remote location and the difficult terrain made the Pacific Power and Light Company's choice of microwave over other possible means of communication mandatory. Only the two stations require servicing and maintenance. Of the signal path, only the reflector is man made, and even that is not subject to deterioration. These factors plus the standby control channel add up to the utmost in reliability.

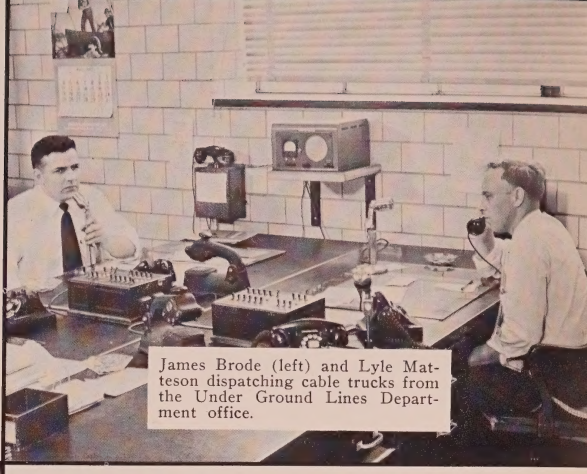


MICROWAVE CHANNEL ALLOCATION CHART

The functions performed by the five microwave channels presently in use in the Pacific Power & Light system are represented in the chart above. Three channels are devoted to the extension of telephone circuits, one is a standby channel, and the fifth is used for telemetering and control. This last channel is effectively divided into nineteen sub-channels by the Audio Frequency Carrier and Vibracode Supervisory Control equipment. The chart rather forcefully presents the economy of channel space effected through the use of supervisory control.



Base station antenna atop The Detroit Edison General Office Building.



James Brode (left) and Lyle Matteson dispatching cable trucks from the Under Ground Lines Department office.

Ernest Schmidt, radio technician, demonstrating the uses of the mobile radio service truck.

A TWO-WAY RADIO SYSTEM for THE DETROIT EDISON CO.

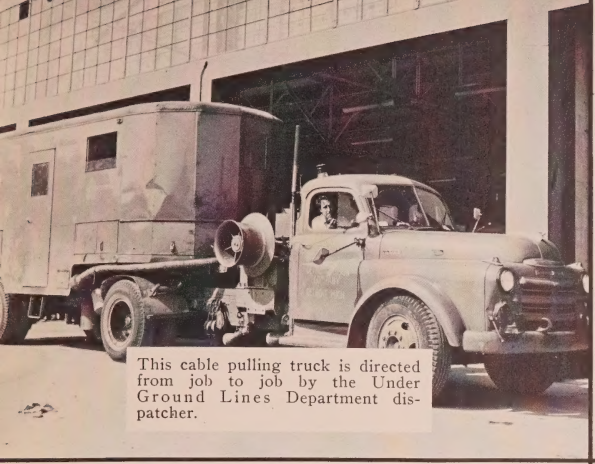
From the 250-watt base station antenna on top of The Detroit Edison Company's General Office Building, two-way radio signals spray out over the entire Detroit area. Receiving these signals are 45 Motorola mobile radio equipped cars and trucks. These units form an integral part of Detroit Edison's vast communications system.

The Detroit Edison Company, situated in the heart of the nation's most highly industrialized area, depends on radio communications to maintain its intricate power distribution system. Under the direction of the Company's Communications Division, the radio system finds wide usage in the following six major fields of operation:

1. For communications from office to system supervisors.

Albert Garner and Bob Willard (on ladder), Substation Department, preparing to check a network bank in downtown Detroit.

Radio Technician Robert Simms making adjustments on the main station transmitter and receiver.



This cable pulling truck is directed from job to job by the Under Ground Lines Department dispatcher.

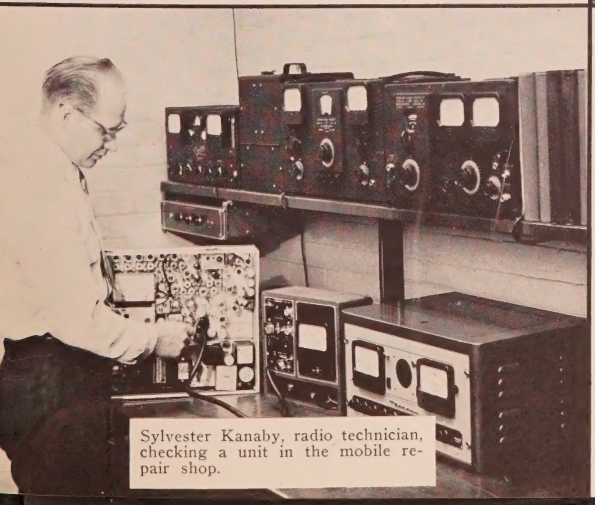
Bernard Bladen using a Motorola pack set while locating a cable fault by the sheath drop method.

2. In the Under Ground Lines Department which handles the installation and maintenance of power lines.
3. By the Fault Location Group in cable testing.
4. By the Substation Department which maintains network banks.
5. By the Stores Department for use in handling strategic materials.
6. By the Communications Division maintenance personnel.

In addition to the base station located in downtown Detroit, two other stations equipped with 250-watt transmitters, one at Port Huron and one at Ann Arbor, are used for emergency standby communications when the Company's privately owned telephone system is disrupted.

Photos Courtesy of The Detroit Edison Company.

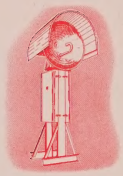
John Barman, Substation Department dispatcher, at the Report Office console.



Sylvester Kanaby, radio technician, checking a unit in the mobile repair shop.

The driver of a Stores Department cable truck takes a call from his dispatcher.

MOTOROLA MICROWAVE COORDINATES OPERATIONS for PANHANDLE EASTERN



Microwave systems are rapidly taking over the communications load for the pipeline industry. This is evidenced by the fast growing number of pipeline companies switching to microwaves for low-cost, dependable communications. These up-to-the-minute systems have long ago passed through the stage of infancy. Today, thousands of miles of microwave systems parallel the pipeline paths providing dependable point-to-point communications for the crude oil and natural gas transmission systems.

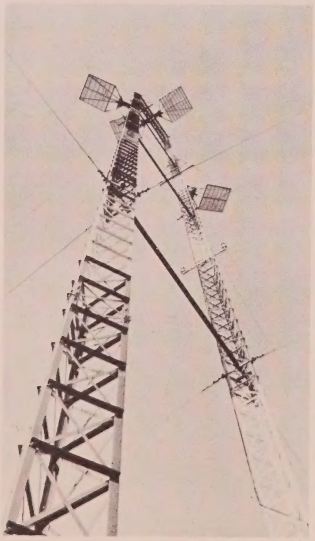
Recently, another Motorola microwave system was placed in operation by the Panhandle Eastern Pipeline Company. This system, extending over 400 miles, is used for point-to-point communications over the pipeline path extending from Kansas City, Missouri to Tuscola, Illinois. Nine attended and nine unattended stations relay the signal from one end of the system to the other. The intervening attended stations are located at Houstonia, Boonville, Centralia and Mexico in Missouri and Pittsfield, Pleasant Hill and Glenarm in Illinois.

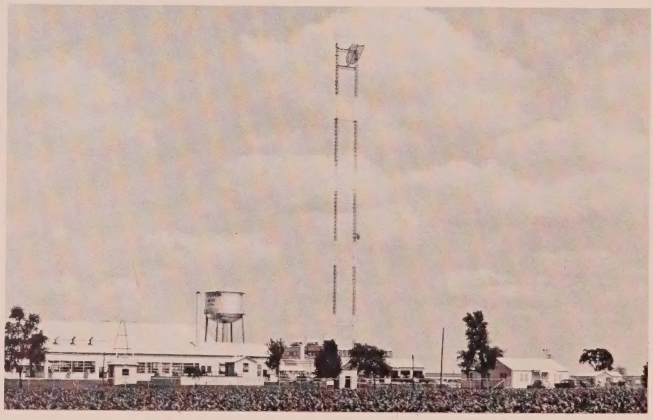
Panhandle Eastern is not a newcomer to the field of radio communications. Before installation of the microwave system, the company had an extensive VHF system which tied the pipeline stations together. The need for a greater number of channels for their growing operations, however, started their thinking in terms of microwave systems.

CHANNEL UTILIZATION

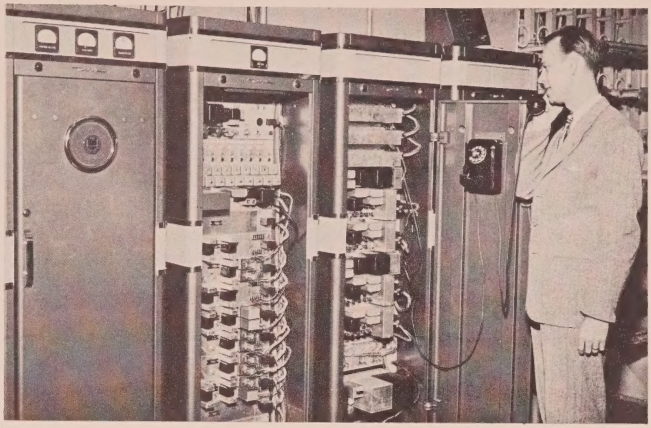
The Panhandle Eastern microwave system is capable of handling ten separate channels. At present, seven of these channels are in operation, thus leaving three additional channels for future expansion. Five of the frequency sharing channels are used for the transmission of voice signals. The two remaining channels are used for telemetering.

The five voice channels include a private line between the two system terminal points at Kansas City, Missouri and Tuscola, Illinois. At Kansas City, the duplex channel terminates in a





ABOVE: View of Panhandle Eastern's microwave station at Tuscola, Illinois. This is the terminal station at the eastern end of the 400 mile system. LEFT: Unique double stub circuits at Liberty School beams microwave energy in four directions—toward Mexico and Glenarm on the main line, and Pittsfield and Pleasant Hill on spur lines.



RIGHT: Subcarrier multiplex and termination equipment cabinets at the Midland Building in Kansas City, Missouri. Mr. Jim Fowler, superintendent of communications, talks directly with compressor station personnel miles away.

PBX which permits the call to be directed to any of the various offices at pipeline headquarters.

Three of the voice channels are push-to-talk party lines. One is an all-station party line, the second is an all-compressor station party line on which only compressor station personnel can talk and the third is an all-pipe line party line for carrying on conversations between the various pipeline district headquarters. Signalling on these party lines is accomplished by selective dialing equipment.

The fifth voice channel ties in with the Company's VHF radio system. This arrangement provides mobile-to-station and station-to-station communications.

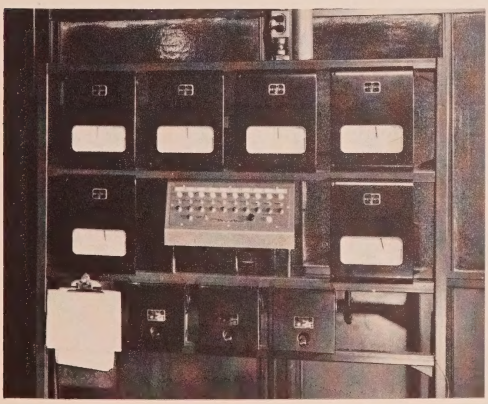
The two telemetering channels automatically track the pressure gauges at the compressor station along the system and transmit the data to duplicate gauges in the pressure department at the Kansas City office.

STAND-BY EQUIPMENT

All stations on the Panhandle Eastern microwave system are equipped with stand-by facilities. A fault in any of the circuits of the microwave RF equipment is immediately detected by sensing units. Within seconds, duplicate RF equipment takes over and communications continue uninterrupted.

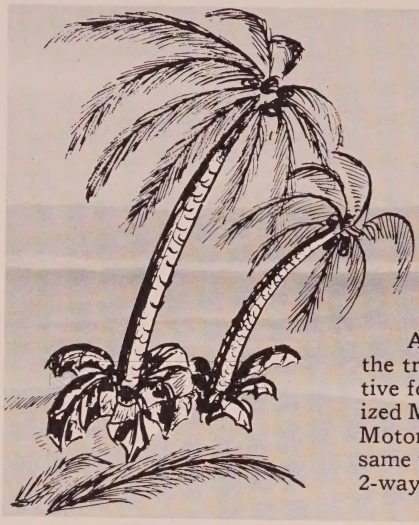
In the event of a primary power failure, stand-by gasoline engine driven generators automatically pick up the load. When the commercial power is again available, the generators return to the stand-by condition.

A failure at any station in the system automatically transmits a coded alarm signal to either Tuscola or Kansas City. Indicator lights on an alarm panel at these locations provide a visual indication of both the nature and location of the fault.



ABOVE: View of the telemetering gauges at the Tuscola terminal station. Small panel in center is a remote alarm panel. Location of panel permits alarm conditions to be checked when pressure readings are taken.

RIGHT: VHF system tied into microwave circuits extends range of VHF coverage.



MOTOROLA in HAWAII

A single organization in the Hawaiian Islands holds the triple responsibility of being official sales representative for Motorola Communications equipment, an authorized Motorola Service Station with the task of maintaining Motorola equipment in top operating condition, and at the same time, an agency for leasing complete Motorola F.M. 2-way radio systems.

The Mutual Telephone Company of Honolulu operates in most aspects similar to other companies who perform one or more of these duties. However, unique operational problems do arise because the five major islands of the Hawaiian group are widely separated.

OPERATIONS

Although the 2-way equipment leaves the factory in perfect operating condition, rough handling enroute can cause adjustment changes even in the most rugged equipment.

Immediately upon receipt of a new shipment from Chicago, all equipment is thoroughly checked in the Mutual laboratory with the most modern test equipment, for receiver sensitivity, operating frequency, frequency deviation and R. F. power output.

Mutual Telephone offers a complete installation service, or will supervise 2-way radio installations if customers wish to do the work themselves. In either case, when installation is complete, a check is again made for operating efficiency, and field checks are made to determine actual areas of coverage. The large staff of trained engineers at Mutual can predict quite accurately final coverage of new installations. The chief problem is Hawaii's rugged topography, for there are sharp ridges, deep valleys and an almost complete lack of minerals in the volcanic soil, all of which hinder radio signal transmissions.

Because the islands are from 100 to 200 miles apart, technical assistance to customers can be assured only by having a resident radio engineer on each island with an ample supply of replacement parts. To supplement the replacement stock, the Motorola Service Station speeds shipments by air express from Honolulu warehouses to any island in less than 3 hours. Resident island engineers provide routine, periodic checks of equipment for those customers having maintenance contracts. Other users get rapid "on call" service at any time. Customers also are assisted by Mutual engineers in licensing equipment and maintaining adequate station logs in accordance with FCC regulations.

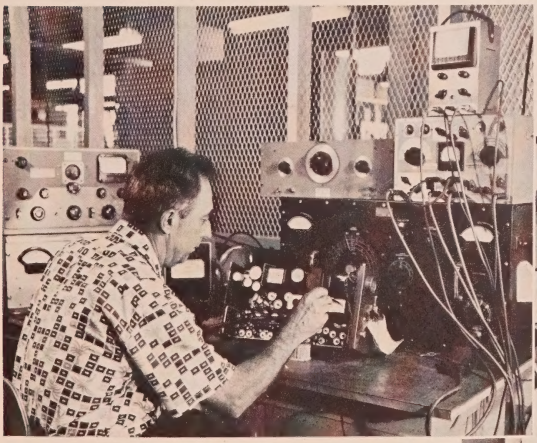
INSTALLATIONS

Major users of 2-way mobile equipment include large sugar and pineapple plantations located on all of the far flung islands of the Hawaiian group. Both purchased and leased systems installed on these farms help dispatch and control fleets of mammoth trucks assigned to hauling fresh fruit to canneries, and sugar cane and molasses to and from the mills. Mobile units installed in supervisors' cars make it possible to greatly broaden the scope and frequency of personal supervision of the vast farmed areas.

In the same way, many police and fire departments on the islands find mobile F.M. 2-way radio as indispensible as their counterparts do in the States. Private companies extend the use of their radio equipment to assist public facilities in time of fire, flood, or other disaster, and speed message flow for the general good.

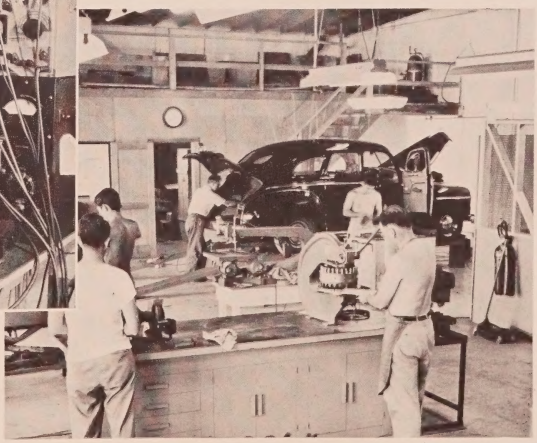
The company has pioneered mobile 2-way radio systems on the islands until today there are many installations on every island. This most modern means of communications meanwhile is finding an ever wider acceptance in the Territory by agriculture, industry, and public utilities.

Mutual's mobile radio shop and electronics laboratory in Honolulu. These completely equipped, modern facilities offer the finest installation and maintenance service available in the Islands and compare favorably with the best available anywhere.



At the rear of this work floor in the Mutual Telephone laboratory in Honolulu a Motorola F.M. 2-way radio is being mounted in the trunk of a car. In this building, licensed radio engineers and technicians are on hand to carry out maintenance contracts with Motorola equipment owners.

Trained electronics technicians staff the ultra-modern laboratory which includes the finest in radio communications testing and measurements equipment. As in Motorola Service Stations everywhere, the technicians are kept up to the minute on all the latest technological information.



POWER CO. INSTALLS TWO-WAY SYSTEM

Harold S. Swain, manager of the Central Division of the Public Service Company of New Hampshire recently stated in reference to the division's newly installed two-way radio system. "The primary purpose of the installation will be to speed up repairs to main power lines and restoration of local electric service to our customers.

"Through the years our emergency men have had to contact a neighbor in the vicinity of the trouble and use his telephone, or travel sometimes great distances through woods and over country roads under trying conditions to call the office. Communication with the trucks was impossible till the men themselves called in. Under the new system installed between Meredith and the trucks, any crew can be reached in a jiffy and necessary instructions given. The two-way radio will be a great boon to us, and, of course, to our customers, too."

The system whose function is so aptly described by Mr. Swain consists of a base station at Meredith, New Hampshire, and 21 mobile units, seven installed in passenger cars and 14 in trucks. The vehicles are stationed at various places in the service area and normally operate within 35 miles of the base station; however, this limitation is not imposed by the radio system as the signal has been consistently picked up in Keene, 75 miles away, and in other towns not quite as far.

The Meredith station is located on Gilman Hill. The transmitter is housed in a specially built concrete block building and the triangular tube-steel antenna tower is on the top of the hill nearby. The antenna stands 167 feet above the surrounding terrain, 1207 feet above sea level.

In addition to the other equipment, three Motorola "Handie-Talkie" Radiotelephones have been provided for use in emergency patrols on foot of the high tension transmission lines. These sets are kept in Meredith.

All the trucks are modern, efficient and well stocked with the assortment of tools, wire and material required to handle almost any emergency without returning to the station. Such a stock plus two-way radio assures the utility customers throughout the central part of the state of added speed and efficiency in the handling of electrical problems.

In an extreme emergency, the system could be used to maintain communication throughout the central part of the state of New Hampshire.

The base station incorporates a 250 watt transmitter. The system operates on a frequency of 158.25 megacycles. The call letters are KCC378.

A transmission line patrol party reports on line condition over "Handie-Talkie" radiotelephone to line truck 5 miles away.
(Photo Courtesy of Laconia, N. H., CITIZEN)

Two of Iowa Public Service Company's storm-burdened repairmen and a radio dispatched service truck are shown above. *(Photo Courtesy of Schleswig, Ia., LEADER)*

UTILITY FIGHTS STORMS WITH RADIO

Recently, three weeks after the Iowa Public Service Company had installed a Motorola two-way radio system, two storms struck West Central Iowa in quick succession with destructive force.

Windblown trees and branches fell on power lines to disrupt service. Lightning struck power installations to blow out transformer fuses.

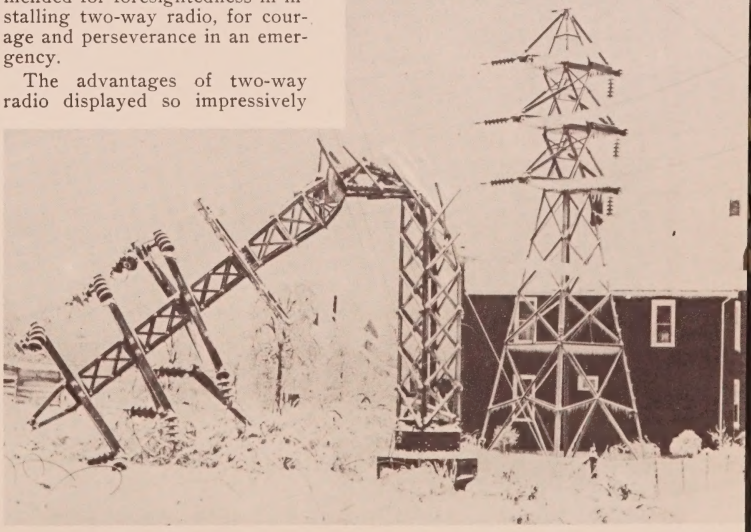
The fury of the storms was spent mostly on three Iowa towns, Schleswig, Ricketts and Charter Oaks, and the surrounding areas.

Just four weeks earlier, repair of the system would have been a slow and awkward operation without constant communication between repair trucks and central station. After finishing each job or series of jobs, the repair crews would have had to locate a telephone, a difficult task at best late at night in a rural community, or return to the central station for further instructions. When the central station was notified of a particularly urgent repair job, nothing could have been done until contact with a crew was established. Thus, the crews would have been operating most inefficiently when efficiency was a matter of utmost importance.

However, with radio, the central station and repair crews were able to remain in constant communication. As each job was completed, the crew called in for another assignment without delay. As the dispatcher knew where each crew was located at all times, travel time between jobs was minimized. When an especially urgent job came in, it was assigned to the crew nearest the job rather than the first to call in.

Even with radio, the undertaking was overwhelming. Before service was restored to normal, three repairmen had put in close to 24 hours without rest. The Iowa Public Service Company and its personnel are to be commended for foresightedness in installing two-way radio, for courage and perseverance in an emergency.

The advantages of two-way radio displayed so impressively against the stormy backdrop accrue also, though on a scale less grand, to the power company which employs such a communication system under normal operating conditions. Even before the storms, the Iowa Public Service Company was using its manpower and equipment more efficiently each day as more and more occasions to use the two-way system presented themselves.



Scenes such as this are the power companies' despair. Two-way radio expedites the return to normal operation.

AGRA-LITE POWER ADOPTS VHF

ABOVE: The Agra-Lite dispatcher is calling a repair crew out in the field to switch it to another, more imperative job.

•

RIGHT: The crew truck driver receives the call immediately. Instantaneous communication pays dividends to co-op members.

"From the standpoint of our initial investment of $7,500, the two-way radio saves more money in operating and maintenance expense than anything else of the type we have invested in." So Victor Hanson, manager of the Agra-Lite power cooperative in Minnesota, appraises the value of the Motorola system operated by the organization.

He states further that even more important than the time and money aspect is the improved service and maintenance it enables Agra-Lite to provide.

Many examples could be quoted. Before the installation of two-way radio, when crews were out in the field repairing outages and breaks in the circuits, they had to return to the main office or find a farmhouse and call in after each assignment for further instructions.

During a severe electrical storm, many times the telephone circuits are down, necessitating a trip back to Benson, the site of maintenance headquarters. This situation does not occur with the new communication system, for a truck may be switched back and forth between breaks as they are reported.

"In this way, we are able to keep a crew or crews busy all day without their having to report back here once," Mr. Hanson relates.

The base station transmitter operates on a frequency of 47.83 megacycles, and is located in the Benson municipal power plant. Its antenna is on the top of the Benson water tower, 148 feet above the ground.

At the present time, Agra-Lite has three remote control units, one located in the home of line foreman Harold Sharpe in Benson, and the other two in the main office. One more remote control unit is soon to be installed at the Western Minnesota power plant just west of Benson. The three remote control units are connected to the main transmitter in the city light and power plant by telephone circuits.

Two-way sets have been installed in seven mobile repair units and the manager's car. Each of the transmitters in the repair units has a power output of 60 watts as compared to the 250 watt output of the base station transmitter.

At the present time, Agra-Lite employees in the Benson main office are able to contact any repair unit in the area serviced by Agra-Lite. The return signal is certain to be heard if the repair unit is within a 40 mile radius and will probably be picked up if the unit is beyond that circle.

Mobile-to-mobile contact is certain up to 10 miles, but is possible over much greater distances unless the terrain is unfavorable.

A log sheet of incoming and outgoing calls is kept in the main office as a simple checkback record of repair operations.

Thus, two-way radio enables Agra-Lite to coordinate its field activities. The central office can keep in touch with the repair crews to shuffle them from one trouble spot to another quickly and with a minimum of effort. By this method, truck crews can also keep in contact with one another.

ELECTRIC CO-OP RADIO SYSTEM SPEEDS TROUBLE-SHOOTING

Economy and efficiency characterize the trouble-shooting operations of the Claverack Electric Cooperative, Inc., in Towanda, Pa., and the surrounding territory since installation of a Motorola two-way radio system.

Costly manpower and equipment are fully utilized for the first time. Once a job is completed, or even before, the repair crew can radio the dispatch office from the cab of the service truck for instructions. No time is lost searching for a telephone or driving in. When an emergency occurs, the dispatcher is in a position to select the crew best able to handle the job and to assign it to them immediately. Before the installation of two-way radio, the dispatcher had no alternative but to wait until a crew called in when an emergency occurred. The first crew to call got the assignment despite work load, despite distance, despite any impracticalities if the emergency was of some magnitude.

Ordinarily, changes in operating procedure initiated to cut costs entail some sacrifice in another area, usually in service to customers. However, the installation of a two-way radio system improves service to cooperative members as it reduces expenses. Service and maintenance operations are speeded up and better coordinated. Everybody profits.

In addition, Motorola units are designed to withstand rugged usage and to facilitate repair when necessary.

One example of Motorola's insistence on minimizing outage time is the Permakay Filter. Although the Sensicon Receiver has more tuned circuits than any comparable units, there are fewer nuisance adjustments to be made in tuning the circuits. This paradox stems from the use of the Permakay Filter which contains 15 tuned circuits adjusted at the factory and forever sealed in solidified polyesterstyrene. These circuits never vary; they never have to be touched by a serviceman; they are unconditionally guaranteed.

Thus the same atmosphere of efficiency and economy which pervades the operation and maintenance of Claverack's power plant also permeates the operation and maintenance of its radio system.

LEFT: Claverack's land station antenna is located on the top of a hill outside Towanda.

•

BELOW, LEFT: A close-up of the remotely controlled, pole mounted base station cabinet just above the base of the antenna pole.

•

BELOW: A radio dispatched station wagon means faster service for members of the cooperative.

BELOW: John Mulligan of Motorola tunes a receiver without removing the chassis from the truck. Simplification of maintenance procedures is a prime objective of Motorola's design engineers.

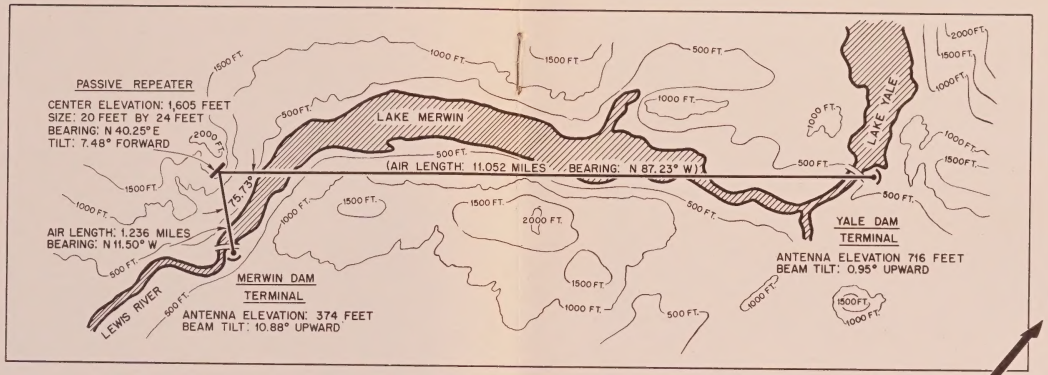
PASSIVE REPEATER FOR PACIFIC POWER & LIGHT CO. INTRODUCES NEW ERA IN MICROWAVE TRANSMISSION

A tough communications problem posed by extremely rugged intervening terrain in the State of Washington was solved recently for the Pacific Power and Light Company by a unique Motorola microwave system.

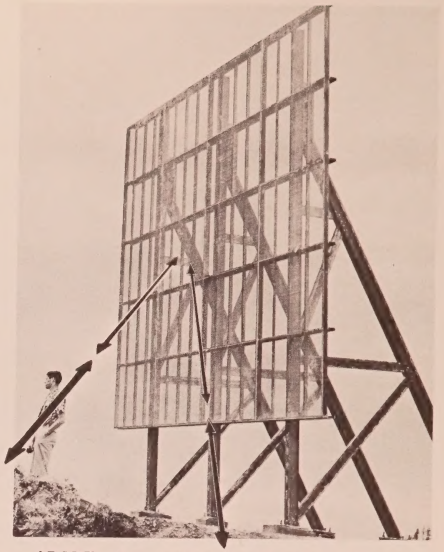
The intervening terrain between the Company's microwave stations at the Merwin and Yale Dams offered no clear line-of-sight path.

The answer was to build a passive repeater, similar to the hundreds of smaller tower-top passive reflectors used on Motorola systems throughout the country and at a point which had a clear path to each station.

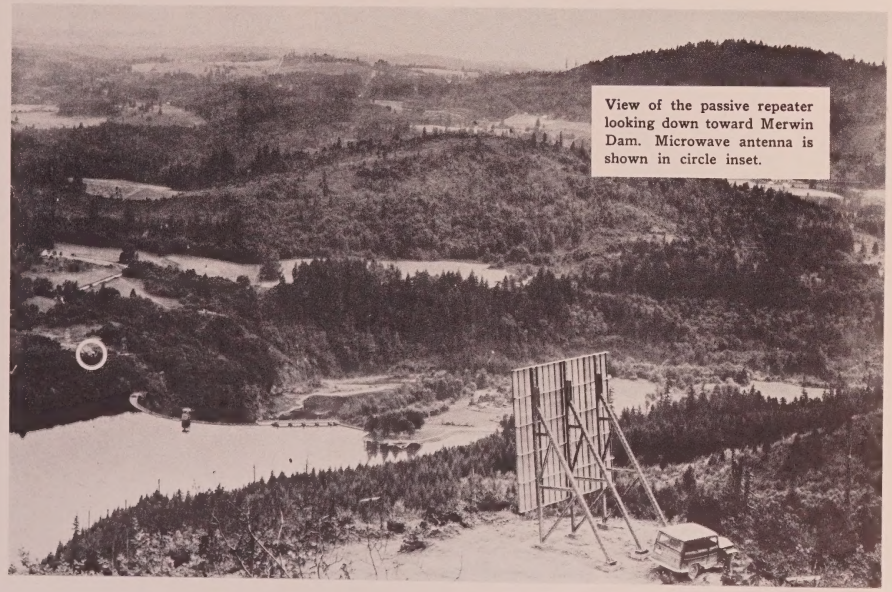
The results have proved conclusively the wisdom of the design. The passive repeater, which represents a saving of over $20,000, and requires practically no maintenance is an efficient radiator. Since it consumes no power, it does not require the installation and upkeep of primary power lines.



ABOVE: Topographic map of the Pacific Power & Light Co. microwave system. Note that a direct path between the Yale and Merwin Dams is completely obstructed. Location of passive repeater permits line-of-sight contact with both locations.



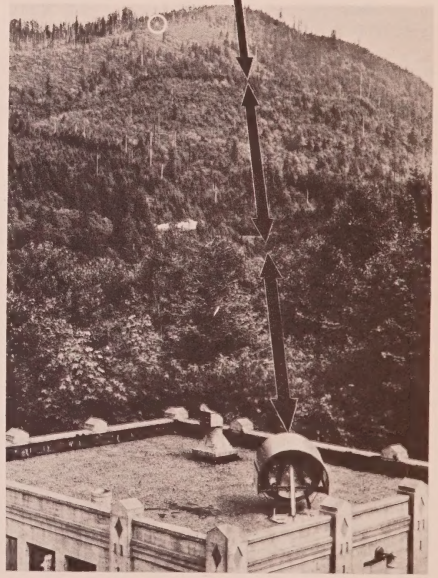
ABOVE: View of Motorola's 20 x 24 ft. passive repeater which receives a signal from one station and re-radiates it toward the second station.

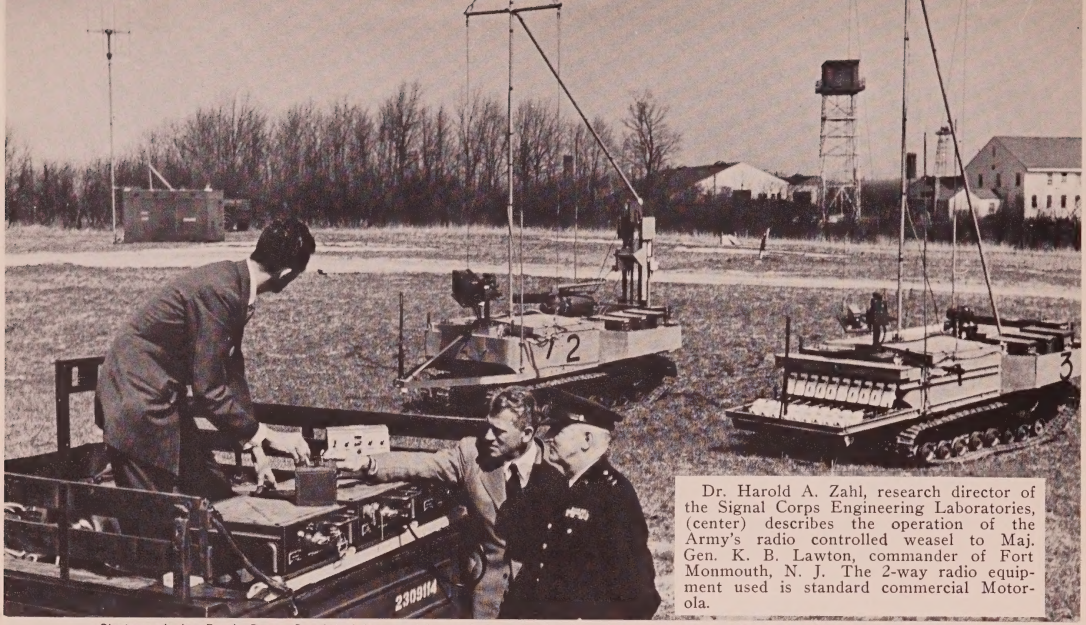


View of the passive repeater looking down toward Merwin Dam. Microwave antenna is shown in circle inset.

ABOVE: Microwave station at Yale Dam. Antenna on top of shelter is directed toward the passive repeater located over eleven airline miles across Lake Merwin.

RIGHT: View of the microwave antenna atop the battery house at Merwin Dam. Passive repeater may be seen in the clearing on the mountain top. Distance to repeater is over one mile.





Dr. Harold A. Zahl, research director of the Signal Corps Engineering Laboratories, (center) describes the operation of the Army's radio controlled weasel to Maj. Gen. K. B. Lawton, commander of Fort Monmouth, N. J. The 2-way radio equipment used is standard commercial Motorola.

Photograph by Frank Ross. Reprinted by special permission of *The Saturday Evening Post*. Copyright 1952 by the Curtis Publishing Company.

MILITARY APPLICATION OF MOBILE RADIO

The U. S. Armed Forces are employing standard Motorola commercial design 2-way radio in many non-tactical operations. For example, Motorola working with a Signal Corps-Ordnance Corps team recently developed a special radio control system for remote operation of a "Weasel". Now de-classified, we can tell you that the radio controlled vehicle with its television cameras, claws and earth sampling bores has been used in atom bomb tests. By remote control the vehicle can be started, accelerated, braked, steered and all of its apparatus manipulated including the making of television adjustments.

LEFT: Standard Motorola 2-way mobile radio in wartime housing is here being used by Army sergeant after first shipment of equipment was made to the Army following outbreak of Korean war.

INDUSTRIAL 2-WAY RADIO

. . . at International Minerals And Chemical Corporation

ABOVE: Although at a great distance from field engineer and instrument man, the rodman and chainman can receive their instructions efficiently and accurately.

Field engineer Jimmy Watson and instrument man Van Orsdale using "Handie-Talkie" unit to issue instructions to the rodman and chainman who are over 1300 feet away.

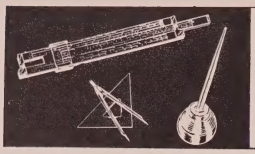
Civil engineer R. N. Bryan, Jr. checks one of the new Motorola "Handie-Talkie" 2-way Radiophones recently acquired by the Florida Phosphate Division of the International Mines & Minerals Corp. for use in surveying work.

. . . and the Westinghouse Corporation

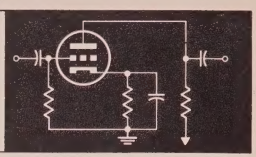
ABOVE: A fork lift truck operator at the Westinghouse Appliance Division Plant, Mansfield, Ohio, acknowledges an order over his truck mounted Motorola FM 2-way radiophone.

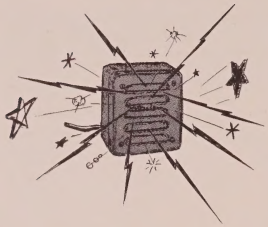
RIGHT: The dispatcher handles the entire fleet of trucks and because of constant contact with the truck he has an accurate up-to-the-minute record of both material location and quantities.

Photos Courtesy of *Partners* Magazine



Technical Notes Section





NOISE REDUCTION in mobile receivers

Noise, in a mobile communications receiver, is more than a nuisance problem. If not kept in check, excessive noise can seriously reduce communications ranges and hamper effective communications at any range.

The noise generated within the radio equipment, such as dynamotor and vibrator hash, is effectively suppressed in any well designed unit. A vehicle can move out of a weak signal area that has a high ambient noise level. But, the only method of countering vehicle noises, such as ignition interference, is to attack the problem at its source. It will be found that these problems are most severe at the lower frequencies (25-50 mc.). At the present state of radio design, it is also found that narrow bandwidth steep sided selectivity characteristics make the receiver susceptible to impulse noise, **regardless of how the selectivity is obtained.** However, noise can be held to a level consistent with good reception if the proper countermeasures are taken.

SOURCE

It is most important that the first step in noise reduction be location of the noise source and the point of entry of noise into the radio system. Countermeasures are only effective if they prevent the noise from entering the radio equipment.

In locating the noise source, the receiver must, in general, be receiving a weak signal, i.e., a signal which quiets the receiver not more than 20 db. Stronger signals may mask noise by limiter action; absence of signals masks noise with inherent receiver thermal noise.

Ignition noise is characterized by regular "popping" or "snapping" following the speed of the vehicle engine. Erratic "popping", increased when lights or electrical accessories are turned on, may be the result of inadequate bonding of various portions of the vehicle body. A whining noise is probably generator interference and rasping sounds are probably produced by gauges, particularly the temperature gauge. Crackling or popping, while the vehicle is in motion, can be the result of static electricity charges on moving insulated parts such as wheels and hubcaps.

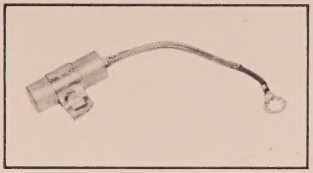
The primary considerations in noise reduction are: (1) reduce the noise at its source and (2) prevent noise from entering the receiver through power, control and antenna circuits wherever possible.

IGNITION

The ignition system is the primary source of radio interference problems. Virtually all radio equipment manufacturers supply shielded by-pass capacitors and distributor noise suppressors as standard installation accessories. One of the capacitors should be connected to the ignition coil primary terminal. The suppressor is to be connected in the lead between the ignition coil and the distributor.

It is also advantageous to keep the distributor breaker points and the ignition system capacitor in good condition. Periodically check for good connections and circuit continuity in the ignition system. Capacitive coupling of ignition noise from high voltage to low voltage leads can be minimized by separating the leads or, in extreme cases, by shielding the ignition coil and running the ignition wiring in a conduit or shield braid.

Standard noise suppressing auto parts are now available for most cars. Resistor type spark plugs contain built-in suppressors and, according to the manufacturer, also provide superior engine performance over conventional spark plugs. Distributors with built-in resistors are available to suppress noise at its source. The complete ignition wiring harness can be replaced with a high resistance cable assembly now being manufactured for most cars.



Two .5 mf. shielded by-pass capacitors (Part No. 8A821889) are included in mobile installation kits and one is included in Kit K-8292.

GENERATOR

Generator noise will normally be adequately reduced with a by-pass capacitor across the output terminals if the brushes and commutator are kept in good condition. The P-346 Generator Filter may be used in series with the output if ever required. A hand-wound choke in series with the generator field may also aid in noise reduction. Unless specifically approved by the vehicle manufacturer, by-pass capacitors must not be used in the generator field circuit, or damage to the voltage regulator may result.

GAUGES

Gauge noise may be detected by jarring the individual gauges with the ignition switch on. The effect of each individual gauge will be made more pronounced by disconnecting the "hot" lead from all gauges other than the one being checked. If the noise continues, also connect a shielded by-pass capacitor at the gauge. One of the most frequent offenders will be the temperature gauge. When a significant change in receiver noise level is detected, by-pass the noisy gauge with a capacitor at the gauge source.

Eight spark plug suppressors (Part No. 6X16621) are included in the K-8292 Hood Wiper and Suppressor Kit.

BONDING

In most modern cars and trucks, the vehicle body and frame forms the ground return for the electrical circuit. Differences in conductivity, inadequate electrical bonds between adjacent conductors, and unequal current distributions result in potential differences throughout the vehicle. The miniature arcs which create radio interference can be minimized by effective use of copper bonding braid and brass contact wipers. Points to check include, in particular, the exhaust pipe, muffler, and hood. The accelerator and choke rods or cables, the brake and speedometer cables, gear-shift linkages, motor block, rear axle assembly, doors, and fenders should also be checked for sources of interference because of inadequate bonding.

STATIC CHARGES

Any insulated moving part is likely to build up a static charge which discharges to produce noise. The worst offender is likely to be the front wheels and hub-caps insulated from the rest of the vehicle by a film of grease. Standard grounding brushes or springs, such as front wheel static eliminators, will satisfactorily kill this interference in most cases where it is present.

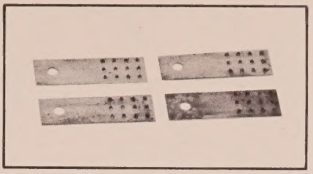
COUNTERPHASING

All Motorola "Research" Line instruction manuals contain, in the receiver section, an alignment procedure to minimize impulse noises if present.

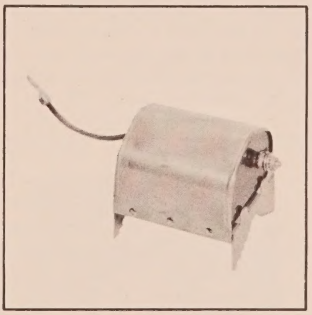
In general, the procedure consists of detuning one of the first IF stage coils slightly until an impulse noise balance null point is reached. The detuning, however, should not decrease the limiter (position 2) meter reading by more than ½ microampere. Refer to the applicable instruction manual for complete details of this procedure. This practice also reduces ignition noise from passing vehicles and other ambient RF impulse noise.

SUMMARY

If the standard practices of by-passing the ignition coil primary circuit and inserting a distributor suppressor are found inadequate, the following practices have been found to clear up most of the special noise problems: (1) Use spark plug suppressors or resistor spark plugs, (2) Bond the motor block and the exhaust pipe to the frame, (3) By-pass the generator brushes, (4) By-pass the temperature gauge at the motor block, (5) Use hood wipers or hood bonding cable, (6) Use a hand wound RF choke in series with the generator field, and (7) Check the vehicle electrical circuits, i.e., the distributor breaker points and capacitor, the generator brushes, spark plug breakdown and high voltage ignition leads. Always be sure that bonding connections and by-pass capacitors have good ground connections. Noise problems will differ in each vehicle so that a standard procedure for all cases cannot be given. However, the above procedures have been found of assistance in most noise reduction problems that have arisen in the past.

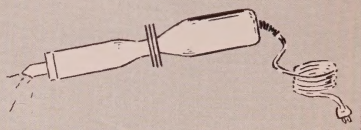


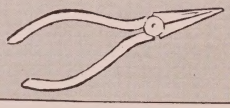
Hood bonding wipers (Part No. 39A4205) included in the K-8292 Kit make positive connection from hood to body.

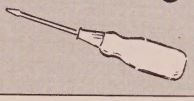


The P-346 Generator Filter, supplied complete with mounting hardware, reduces generator output noise in installations where it is required.

SERVICE HINTS and SHOP NOTES





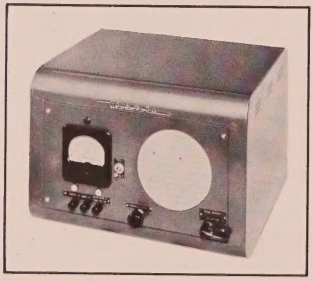


AUDIO RESPONSE

Uni-Channel and Sensicon receivers are designed with audio frequency response characteristics, within RTMA limits, to satisfy the majority of users. To reduce the "booming" quality of audio signals due to transmitter over-deviation or excessive clipping or other causes, a simple capacitor change will provide a crisper audio output signal.

Replace the capacitor across the receiver chassis volume control with a .001 mf. ±20%, 200 vdcw, oil-filled capacitor (Motorola Part No. 8K800115). Normally, a .0015 mf. capacitor is used in Uni-Channel receivers and a .002 mf. capacitor in the Sensicon models.

This change will increase the level of high frequency signal components and slightly reduce the low frequency components. Response will still remain within RTMA limits. This modification should not be made on receivers using selective call equipment operating below 300 cps.



REMOTE CONTROL

The PA-8270 series of Remote Control Consolettes, when used with a remotely installed single frequency base station, must be operated with the F1-F2 frequency selector switch in the F2 position. The reason for this lies in the basic function of the transmitter remote control chassis.

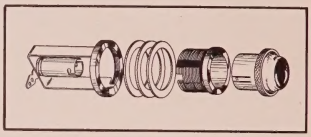
A single frequency transmitter requires a DC control current of approximately 8 ma. ("Deluxe" Line units) to 10 ma. ("Research" Line units) to operate the "transmit" relay.

A two-frequency remote control chassis includes two transmitter control relays. A control current of 4 ma. will operate the "transmit" relay, placing frequency no. 1 "on the air". A current of 10 ma. will operate both the 4 ma. "transmit" relay and a series 10 ma. frequency no. 2 switching relay.

The remote control consolette is normally set to produce a current of 4 ma. in the F1 position of the F1-F2 switch and a current of 10 ma. in the F2 position. Thus, to obtain the 8 to 10 ma. necessary to operate single frequency transmitters, the switch must be in the F2 position.

If the slider contacts on the control current voltage divider in the remote control consolette are moved to a position providing 8 to 10 ma., the position of the F1-F2 switch will be immaterial for single frequency operation. The same result can be obtained by connecting both leads to the high current slider.

PILOT LAMPS

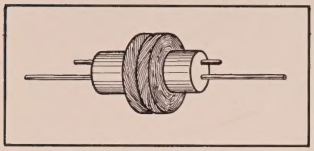


Pilot lamp assemblies with dimmers are available for addition to all Motorola mobile control heads. The light output of the pilot lamp is adjusted by rotating the jewel assembly, varying the orientation of two Polaroid lenses. These are of benefit in achieving driver comfort in nighttime operations.

The part number of the GREEN pilot lamp assembly (less bulb) is 60A86112. The equivalent RED assembly is Part No. 60K86113. The socket accepts the standard miniature bayonet base bulb normally used for this application.

The new assembly is directly interchangeable with the original assembly supplied in the P-8022 series of control heads used with "Deluxe" Line equipment. Most of the P-8422 series of control heads used with "Dispatcher" models already include this pilot lamp assembly. Use in either the P-8442 or P-9022 "Research" Line series of control heads requires an enlarged mounting hole in the control head. Size limitations preclude the use of this assembly in front mount Uni-Channel control panels.

WAVE TRAPS



Long remote control lines (2 miles or more) and control lines in the vicinity of high power broadcast radio stations may pick up RF energy which causes interference with normal operation of a VHF radio communications system. Where this condition exists, 4.3 mh. wave trap coils (Part No. 24A77336) should be installed in each control line. These coils will effectively attenuate this type of RF pick-up and minimize the interference it can cause in either the transmit or receive condition.

GROUND CIRCUIT

When the P-8201-B amplifier chassis is removed from the housing of the PA-8270-E or PA-8270-F Remote Control Consolette, the main ground return circuit between the control panel and the amplifier chassis is interrupted. This will be evident by pilot bulb dimming and excessive noise at the speaker.

An independent ground return circuit may be added, as given below, to eliminate the necessity of a clip lead ground interconnect for servicing the amplifier outside the housing.

1. Connect one end of a 34 inch length of #20 insulated wire to the grounded end (top) of the 1000 ohm resistor, R-3, on the control panel. To comply with standard color coding, a black lead should be used.

2. Route the lead through the insulated sleeving of the interconnecting cable and up to the octal cable plug, P-2.

3. Connect the lead to pin 2 on the octal cable plug, P-2. The ground connection is already made to pin 2 in the mating socket.

This same procedure is also applicable to other models in this series which are constructed in the same manner.

RECTIFIERS

A question arises periodically on use of correct rectifier replacements in the P-8031 and P-8331 Power Supply Chassis. The P-8031 is used with 25-50 mc. "Deluxe" Line transmitters in the FSTR-50B, FSATR-50B, FSTR-250B and FSATR-250B series. The P-8331 is used with 152-174 mc. equivalent transmitters in the FSTRU-50B and FSTRU-250B series. Both power supplies use the same circuitry as shown below.

Late in 1945, circuit changes were instituted to increase rectifier life, decrease operating temperature rise, and maintain adequate output voltage for a longer time period. For best results, power supplies manufactured previous to this time should be brought up-to-date as follows:

1. The filament transformer, T-2, should be Part No. 25B-483001. Part No. 25B85296, now obsolete, is also satisfactory. Both of these transformers have higher output voltage and a lower operating temperature than the original transformer, 25B-81395, which they replaced.

2. The dry disc copper sulfide rectifier, Part No. 48A81413, should be replaced by Part No. 48A84495 which is rated for higher voltage, heavier duty, longer shelf life, longer operating life, and has a greater number of plates, and a higher forward resistance.

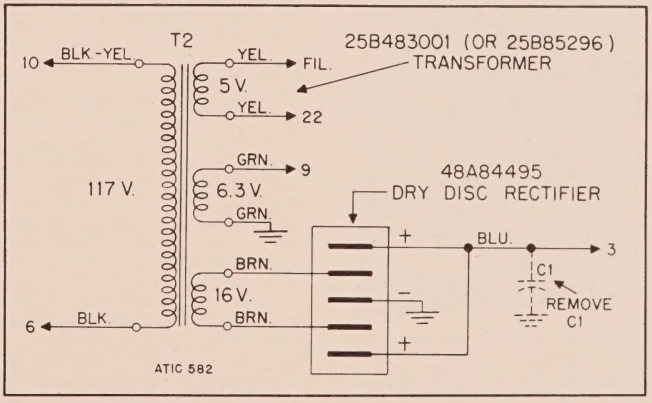
3. Filter capacitor C-1, 2000 mf., Part No. 23A81416, is not required in the new circuit and should be removed.

When revising the circuit, all components listed above must be changed. Satisfactory operation will not be obtained if the correct rectifier is not used with the correct transformer due to differences in voltage ratings and resistances.

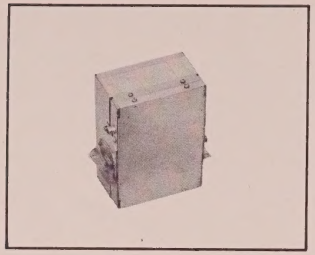
If the original circuit is retained, be sure to check the filter capacitor to ascertain that it is in good condition before replacing the rectifier. Experience has disclosed cases where capacitor failure, due to the high AC currents, has been incorrectly diagnosed as rectifier failure.

TUBE SOCKETS

As a preventive maintenance measure, it often proves practical to remove and reinsert tubes in their sockets whenever a transmitter or receiver undergoes maintenance. Even though the tube socket contacts are normally corrosion resistant, this action will remove encrusted dirt and accumulated foreign matter to insure good electrical contact and prevent erratic or unsatisfactory operation due to this cause.



A partial diagram of the relay voltage section of P-8031 and P-8331 AC power supplies showing the latest circuit details.



PERMAKAY FILTERS

A Basic Description of Motorola Receiver Selectivity Elements.

Forseeing the trend toward receivers of greater and greater selectivity, Motorola engineers placed the "Research" Line receiver on the market in 1949. This type of receiver achieves its selectivity primarily from a band pass IF filter, not from conventional IF circuits. The conventional IF circuits do not, at the present state of radio design, produce adequate acceptance bandwidths while still maintaining high attenuation within narrow limits. A partial solution lies in over-coupled tuned circuits, stagger tuning, and loading resistors but this presents the problems of difficulty of alignment procedures. A practical solution to both satisfactory selectivity and practical selectivity changes was found in the Permakay Filter. A simple exchange of the plug-in filter permits change to any desired channel width with ease and economy.

FILTERS

A simple low pass filter, as illustrated in Fig. 1, may consist of only three inductive or capacitive components. The performance characteristics will be identical for either the "Tee" or the "Pi" section. For the more general case, regardless of the number or type of components in each arm, the symbols "Z_1" and "Z_2" may be assigned to the impedances, as shown in Fig. 2, and the filter may be treated the same whether it is high pass, low pass, band pass, or band stop.

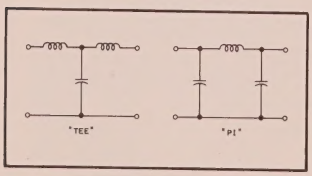


Fig. 1. Elementary Low Pass Filters

CONSTANT-K

By establishing the formula $Z_1 \times Z_2 = k^2$ another fundamental relationship is achieved. The term "k" is equal to the characteristic impedance of the filter. When "k" is thus established, (a constant-k type filter) the filter attains an optimum input and output impedance match to adjoining sections.

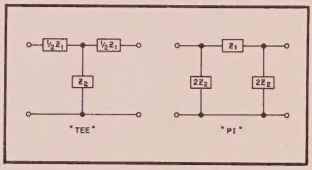


Fig. 2. Basic Constant-K Filter Circuits

M-DERIVED

Unfortunately, a simple filter may not provide an attenuation curve rising sharply enough at the edge of the pass band. While multi-section filters overcome this problem, the insertion loss is increased. One solution is the use of a special form of the constant-k filter section known as the m-derived section. Utilizing a tuned circuit in one of the arms which resonates at a frequency near the filter cut-off frequency, high attenuation is achieved. The values of components used are established by standard formulas making use of an arbitrary constant "m".

PERMAKAY

The Permakay Filter consists of standard filter sections modified and transformed, according to accepted network theory, to fit the desired characteristics of impedance and attenuation. The specially chosen capacitors and permeability tuned coils are assembled and precision tuned at the factory. When tuned, the entire assembly is cast in a solid block of an extremely durable polyesterstyrene plastic. Thus protected, the filter never requires further tuning adjustments and is virtually impervious to the effects of corrosive gasses, dust, solvents, moisture, wide temperature ranges, shock and vibration. Current production models of these interchangeable filters in Sensicon receivers provide 100 db. of attenuation at±30 kc, ±20 kc, or ±15 kc from the center frequency, 455 kc, depending on the selectivity required. Uni-Channel Permakay filters provide 100 db. selectivity at ±35 kc or ±18 kc. Modulation acceptance of the filters (depending on application) is ±15 kc, ±7.5 kc or ±5 kc at less than 6 db. attenuation.

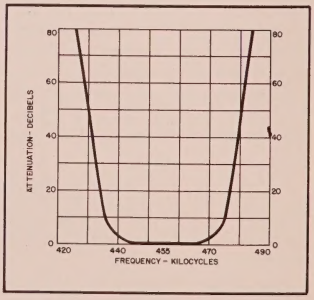
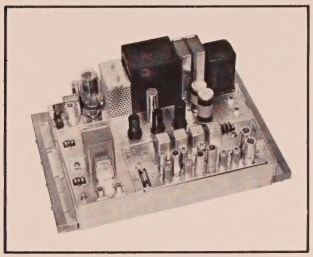


Fig. 3. Typical Permakay Filter Attenuation Curve

NEW PRODUCTS....

TV RELAY

Motorola is now producing, as a new addition to the microwave communications equipment line, a packaged TV relay system for short-haul transmission of television programs. Now, communities off the coaxial cable routes and away from the metropolitan terminals of the cross-country TV relay system can enjoy the benefits of network programming. Now also, an economical system has been developed for an interconnecting circuit between the centrally located studio and the remotely installed transmitter.



Rack mounted video output amplifier and power supply (available separately) and high fidelity program sub-carrier receiver at the receiving terminal.

MICROPLEX

Serving nearly 5000 miles of industrial communications networks, the Motorola FM multiplexed microwave equipment has proved itself both practical and reliable. TV relay is a packaged system, with only two modifications to standard Motorola Microplex type equipment to adapt it to television service. First, the standard sub-carrier transmitter-receiver system for voice communications has been replaced by a high fidelity system for maximum audio quality in the program signal. Second, the modulating and demodulating equipment has been designed for direct connection of the video signal to the RF section without the use of sub-carriers. With the exception of 12 inches of rack mounted equipment at the receiving terminal, all essential components are contained within the standard RF outdoor housing at each terminal or relay station.

VIDEO

The video input signal is fed into a 75 ohm unbalanced circuit at a nominal level of 1 volt peak-to-peak (300 mv. peak-to-peak minimum). At the receiving terminal, up to 1.5 volts peak-to-peak is fed into a 75 ohm unbalanced load of either polarity or a 110 ohm balanced load. Video response is essentially flat with less than −0.2 db at 60 cycles and less than −2.5 db at 4.5 mc.

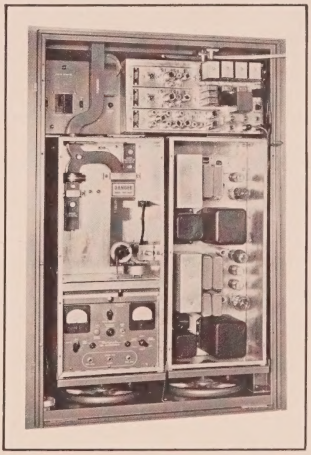
The system is completely free from sync. pulse compression. The video output amplifier at the receiving terminal, if used alone, has a frequency response characteristic of less than −1 db at 10 cycles and less than −3 db at 7 mc.

PROGRAM

Designed to work with standard line impedances of 600 ohms, the program circuit operates with a minimum input of −10 dbm and a maximum output of +5 dbm, with nominal values of 0 dbm. Audio frequency response is better than +0, −3 db from 50 cycles to 14.5 kc. Distortion is less than 1% at mid-range and less than 1.5% at the ends of the range. The signal-to-noise ratio (with flat weighting) is better than 60 db.

ORDER WIRE

A two-way push-to-talk service channel with push-button ringing is built into the equipment. Designed for the audio spectrum, 300 to 2700 cycles, the 600 ohm circuit is built for nominal input and output levels of 0 dbm. It is capable, however, of satisfactory operation with a −10 dbm. input and a +20 dbm. output. Each relay station, as well as each terminal station, may be equipped with telephone instruments connected into this service channel. The self-contained talking battery will accommodate circuits of up to 50 ohms loop resistance. Full details of this new equipment are contained in brochure ATIC-455, available from the Technical Information Center.



Interior of TV Relay RF Unit: program and order wire sub-carrier equipment, top right; RF plumbing, left; test equipment, lower left; power supply, lower right.

SELECTIVITY CONVERSION

in "*RESEARCH*" Line Receivers

All Motorola "Research" Line receivers have been designed for ease of conversion to a greater degree of selectivity. This feature precludes receiver obsolescence as plans proceed for narrower channel assignments. The modification is accomplished by adding or changing the Permakay Filter and, in some cases, a few minor components.

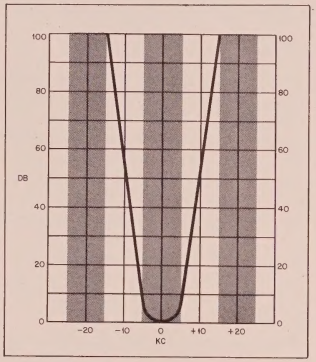
SELECTIVITY

Sensicon receivers are currently manufactured in four degrees of selectivity for the 25-50 mc. range. The PA-9137 series, with the K-9103 Tunable Filter, achieves a selectivity of −100 db. at ±120 kc. with a modulation acceptance of ±15 kc. With the K-8436-A Permakay Filter, the PA-8633-A series of receivers achieve a selectivity of −100 db. at ±30 kc. while retaining the ±15 kc. modulation acceptance. To aid in rejecting adjacent channel signals, the PA-8663-A series of receivers, with the K-8435 Permakay Filter, have a selectivity characteristic of −100 db. at ±20 kc. and a modulation acceptance of ±7.5 kc. While this receiver is sometimes termed a "split-channel" receiver, better selectivity is available for this type of application. Designed specifically for narrowed channel applications, the PA-8663-S series including the K-9245 Permakay Filter are 100 db. down at ±15 kc. and have a modulation acceptance of ±5 kc.

CONVERSION

To convert a PA-9137 to ±30 kc. selectivity, it is only necessary to replace the K-9103 Tunable Filter with the K-8436-A Permakay Filter. No additional transmitter or receiver changes are required.

To convert a PA-8633-A (or its equivalent) to the narrower ±20 kc. bandwidth, the K-8435 Permakay Filter replaces the K-8436-A. Resistors R-317 and R-322 (47,000 ohm loading resistors for coils 307 and 308 in the 2nd IF section) must be clipped out. Resistor R-348 at the discriminator secondary is changed from 22,000 ohms to 47,000 ohms for increased discriminator recovery. The transmitter modulation control potentiometer is then set for ±7.5 kc. maximum modulation deviation and the conversion is complete.



Selectivity performance of the PA-8663-S Sensicon receiver on a theoretical 20 kc. channel spacing basis.

Conversion from ± 20 kc. selectivity to ±15 kc. selectivity achieves narrowed channel operation (often called "split-channel"). The K-8435 Permakay Filter is exchanged for a K-9245. In addition, the following changes are made: (1) Resistor R-317 (47,000 ohms) is added across coil 307 in the 2nd IF (2) A 1 megohm resistor and a .02 mf. capacitor are added from the AGC bus to ground, (3) The discriminator input resistor, R-348, is changed from 47,000 ohms to 180,000 ohms, (4) The discriminator load resistor, R-350, is changed from 470,000 ohms to 1 megohm, and (5) The capacitor across the volume control, C-368, is changed from .001 mf. to .002 mf. The transmitter is then set for ±5 kc. deviation to complete the conversion.

LABOR

Field conversion is practical and economical. The exchangeable Permakay Filter is mounted with four screws and has two plug-in connections. In no case is it necessary to unsolder and remove IF coils or work with components inside coil cans.

UNI-CHANNEL

Current versions of the Uni-Channel receiver (PA-9244 series) are also convertible in selectivity. Receivers are currently being supplied for standard channel spacing in either of two selectivity characteristics. Attenuation of 100 db. at ±120 kc. is achieved with the K-9242 "Tri-K" Filter or 100 db. at ±35 kc. with the K-9241 Uni-Channel Permakay Filter, both with a modulation acceptance of ±15 kc. A narrowed channel filter, the K-9240, achieves a receiver selectivity of −100 db. at ±18 kc. with a modulation acceptance of ±5 kc. Conversion is accomplished in the same manner as in the Sensicon receivers.

CAUTIONS

While better selectivity provides rejection of signals closer to the desired signal, it cannot compensate in full for the effects of intermodulation, desensitization or similar problems. Changes in selectivity should be made only when it is determined that the change will provide the answer to an interference problem.

SPLITTING 545∿ 3105∿ AUDIO CHANNELS

When several telegraph, teleprinter or telemeter functions can be combined on one channel, it is economically impractical to occupy a full audio frequency channel for each function. Motorola Audio Frequency Carrier fulfills this need for efficient spectrum usage and may be used on any audio channel on wire lines, in VHF radio systems on power line carrier networks, on telephone carrier systems, or in microwave communications systems.

CHANNELS

Motorola AF Carrier provides a total of 18 channels in the 500-3100 cps. range. The total number of channels that may be used in any system depends upon the audio bandpass of the transmission system. A spacing of 150 cps. is maintained between channels with the lowest at 525 cps. and the highest at 3075 cps.

KEYING

The simplest method of keying is, of course, an open-closed switching function such as the external "dry" contacts of a telegraph key, a teletypewriter, a Bristol "Metameter" telemeter transmitter or other equivalent coding devices.

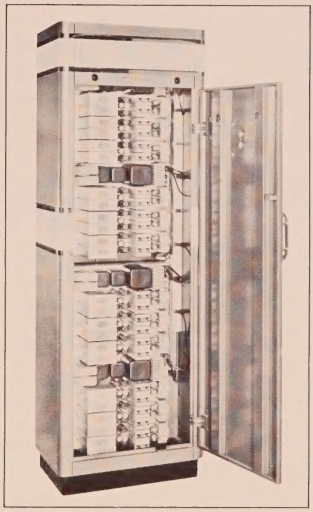
A second method is the "on-off" current or variable current signal used on land telegraph lines and similar signaling systems.

The third method employs a sub-audio sinusoidal signal (0 to 35 cps.) such as obtained from a Leeds and Northrup or equivalent telemetering instrument or any audio oscillatory device.

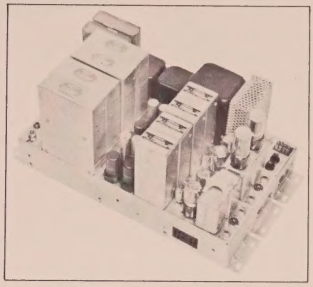
Both of the first two methods result in a frequency shift from the "mark" frequency 30 cps. above the channel center frequency, to the "space" frequency, 30 cps. below the channel center frequency. The receiver discriminator then operates a polar relay to duplicate the input signal. In the third method, the input signal frequency modulates the transmitter with a deviation of ±30 cps. The receiver discriminator recovers the original signal.

CHASSIS

Each transmitter and each receiver chassis is designed to accommodate two separate AF carrier channels. A single power supply chassis provides both filament and plate voltages for as many as 12 channels, depending upon the information being transmitted. Each chassis offers a terminating impedance (500/600 ohms) to the line at its own frequency but a bridging impedance is offered at all other frequencies. This feature is achieved through use of a fixed tuned, plastic-encased ISOKAY Filter both at the transmitter output and the receiver input.



Twenty-four AF carrier receiving channels are shown mounted in the cabinet above.

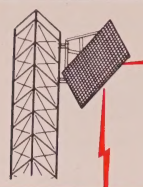


Plug-in connectors permit "stacking" of chassis without interconnecting cables as illustrated by the two receiver chassis and power supply chassis above.

The transmitter is designed for a power output adjustable up to a nominal value of 0 dbm. The receiver sensitivity is nominally −26 dbm. (3 db. below full limiting). Since this specification assumes high noise levels, considerably better sensitivity is achieved on most circuits. FM transmission of information provides a receiver output signal that is independent of wide changes in signal level and noise.

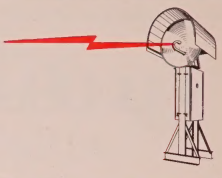
APPLICATION

In addition to use for transmitting telemeter, telegraph, teletypewriter, telephone dialing and similar signals, AF carrier also has application in the field of load control. Two channels may be used, one for the "raise-neutral" signals and one for the "lower-neutral" signals as described in the December, 1951, issue of the "Newsgram". Through the use of appropriate high pass and low pass filters, also available from Motorola, AF carrier may be multiplexed on a channel with voice communications by reducing the voice spectrum slightly. Audio frequency Carrier is a practical, dependable, economical means of transmitting coded information of many types.



WHAT IS

MICROWAVE ?

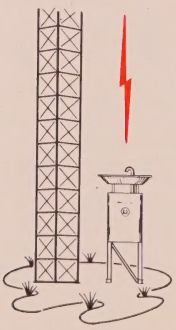


Microwave, America's fastest growing communications medium, is more easily understood if considered as a marriage of standard radio engineering techniques to a few specialized new developments. Definitions given herein attempt to outline the primary features of these new developments and explain how they unite to form a communications system.

Because of their short wavelength, all frequencies above 900 mc. are generally termed "microwave" frequencies. Microwaves closely approximate the characteristics of light waves and optical terms such as reflection, refraction, absorption, focus, and "line-of-sight" apply. Motorola chose high microwave frequencies in the 5925-7125 mc. region (a wavelength of approximately two inches) for its standard systems. At these frequencies, extremely efficient propagation characteristics are realized; highly directive but yet compact parabolic antennas can be used in conjunction with low power transmitters; tubes are moderate in price and have exceptionally long life; and waveguides become an efficient, practical means of RF energy transmission.

MULTIPLEX

The advantages of microwave over wire lines are multiplied when many channels of communication are established on a single microwave carrier. The equipment used to combine individual channels on a common RF carrier is termed "multiplex".



One method of multiplexing is the time-division system. Basically, this system consists of two synchronized electronic or mechanical sampling switches. At the transmitting terminal one switch takes closely spaced "samples" of each input signal and applies the composite result to the RF carrier. At the receiving terminal another "switch" samples the carrier to recover the individual input signals.

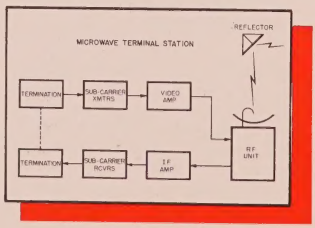
In the Motorola method of multiplexing, a frequency-division system, each input signal is fed to its own low frequency FM transmitter. The combined output of up to 24 such sub-carrier transmitters is then used to frequency modulate the RF carrier. At the receiving terminal, separation filters and individual FM sub-carrier receivers demodulate the RF signal into its component channels.

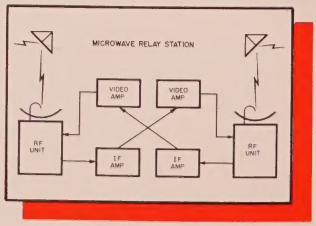
Each audio channel is designed for an approximate range of 300 to 3000 cps. This spectrum is suitable for voice communications, for supervisory control tone code signals, or for up to 18 channels of audio frequency carrier for load control, telemetering, teleprinter, and similar operations. A frequency shift technique may be used on voice channels for telephone dialing, signaling or ringing functions.

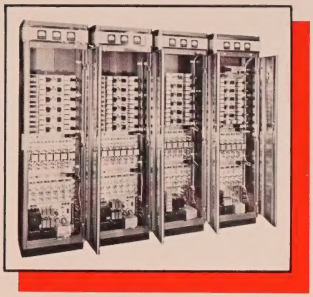
RF EQUIPMENT

Microwave terminals are compatible with standard telephone practices. Sub-carrier transmitters and receivers follow conventional design principles. Except for voltage regulating circuits, power supplies are similar to standard communications receiver supplies. Unusually low noise factors and considerable reserve gain differentiate video amplifiers and IF amplifiers from conventional units. However, the RF circuits employ waveguides and klystrons, not used in other communications equipment.

A klystron consists of only three basic elements: (1) a heated cathode as an electron source, (2) a tuned cavity which is the control grid, the oscillator tuned circuit, and, in turn, the anode, and (3) a negatively charged plate, the "repeller". As the electrons from the cathode pass through the cavity, their velocity is increased or decreased depending upon which portion of the oscillatory cycle they spend in the cavity. The "speeded-up" electrons tend to "catch-up" with the "slowed-down" electrons, effectively "bunching" the electron beam. As the beam approaches the repeller, the "bunches" are repulsed back to the cavity, yielding their energy to it and sustaining the oscillations. An RF probe transfers the energy from the klystron tuned cavity to a waveguide.







Complete multiplex and termination equipment for a 24 channel "Remote" type microwave station is shown above.

The klystron resonant frequency can be changed by either of two methods. For coarse tuning, the size of the cavity is changed slightly with an adjusting screw. For fine tuning as well as for modulating the klystron, the repeller voltage is changed.

ANTENNAS

The RF energy from the transmitter is conveyed via waveguide to a parabolic "dish" antenna. The waveguide is a hollow rectangular "pipe", the most efficient transmission line at these frequencies. Waveguide also acts like a high pass filter, preventing extraneous noise and signals below approximately 4300 mc. from interfering with either transmission or reception.

At the waveguide "horn" fed "dish" antenna, the RF energy is concentrated into a highly directional beam, less than 3.5 degrees between half power points. If the location of the RF equipment is at an elevated location, the antenna is mounted on edge and the signal beamed horizontally to the next station. Where additional elevation is required, the beam is directed vertically to a 45° parabolic reflector which in turn reflects the beam horizontally to the next station. This practice keeps the RF equipment at ground level for ease of servicing and also eliminates the necessity of signal losses in coaxial cable or waveguide to tower top antennas.

Twin towers are used for maximum resistance to torsion and deflection under high winds and icing conditions. Since the installation is extremely rugged and the microwave system has widely spaced stations, microwave is much less vulnerable to outages in storms than the conventional wire lines.

AUXILIARY

Microwave includes additional circuits not normally found in VHF radio. Automatic fault locating equipment transmits coded tone signals to pinpoint the type and location of an equipment failure. Automatic frequency control keeps the receiver "in-tune" with the transmitter and a frequency sweep circuit "finds" the transmitted signal if it is lost for any reason. Tuned waveguide cavities make duplex operation practical. Frequency monitors are built in to all RF equipment. Automatic switchover transfers operation to a standby unit if the main unit ceases functioning normally.

The klystron is the heart of microwave RF equipment.

STATIONS

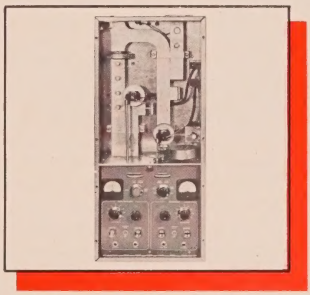
A terminal station usually contains a single RF terminal unit and multiplex equipment to make use of all channels in use on the system. A relay station consists of two RF terminal units mounted "back-to-back" for transmission and reception in both directions along the system. The relay station may also contain "drop channel" multiplex equipment to receive and transmit signals desired at that station. "Stubs" may also be provided to stations off the main microwave system with as many channels as necessary. These channels are available to the stub terminal, either directly or through additional relay stations.

TYPES

Motorola classifies stations into three basic categories: "Microplex", "Micropackage" and "Remote". "Microplex", not to be confused with "multiplex", is the simplest form. A single weatherproof housing contains all RF and control equipment. Microplex is ideal where standby units are not required and where only a limited number of channels are required.

"Micropackage", capable of being supplied with standby and automatic switchover units, is completely contained within a standard shelter building. All chassis are open rack mounted.

"Remote" type equipment derives its name from the fact that RF equipment is located in outdoor weatherproof housings and is remotely controlled, tuned, and adjusted via a cable from the nearby indoor mounted multiplex and control equipment. Remote stations are mainly used where existing structures are available to house the multiplex and control equipment and provide suitable means for achieving line-of-sight clearance.



An RF box contains klystrons, waveguide plumbing and, at the bottom, a control panel.

TRANSMISSIONS . . . . .

About Motorola 2-Way Radio Users

RADIOS TO FIREMEN AS CYCLE BURNS • • •

A Kirkwood, Missouri police officer used the two-way radio on his burning motorcycle recently to summon the fire department to put out the blaze.

Patrolman Kenneth Schatz was riding on Seger Road near Big Bend Blvd., when his motorcycle skidded on oil that had been spilled on the pavement. Sparks from sliding stones ignited the oil which in turn set the vehicle on fire.

With the fire smoldering around him Schatz managed to use his radio to send a call for help. Kirkwood firemen arrived on the scene within minutes and put out the fire. Schatz escaped without injury.

Thanks to the quick response of the fire department made possible by Kirkwood's modern two-way radio system, Assistant Chief Kenneth Peek was able to report that only minor damage, limited to motor wires and paint, was done.

Homer Marrs, Motorola communications sales manager of region 3, is now wondering if Motorola can't figure a way to make the two-way radio set squirt water too!

THE DETROIT FREE PRESS REPORTS • • •

Mrs. S. L. Courtney, of Detroit, Michigan, will swear her life away that the Detroit Fire Department is not only effective, it travels on flying saucers. Mrs. Courtney reported a fire recently with all the dread of the terrified householder welling in her throat. She was just putting down the receiver when Engine 31 pulled up in front and doused the blaze. As Commissioner Mahon relates it, there was nothing supernatural involved—just the magic of two-way radio and the fact that Engine 31 had just put out a small fire two blocks away. The dispatcher sent them on their way while he was still talking to Mrs. Courtney.

FOR GREATER SPEED AND COORDINATION • • •

Buck's Ambulance Service of Portland, Oregon recently installed a Motorola two-way radio in their airplane-ambulance.

The air ambulance two-way radio operates on the same frequency as their six auto ambulances. Barney Buck, who manages the firm, states that when in the air, they are able to communicate directly with Seattle, Wash. to the north and Eugene, Ore. to the south. Their typical operation is generally similar to the following example of how two-way radio enables an auto ambulance to be coordinated with the air ambulance for the necessarily speedy trip from a remote area to a hospital. The air ambulance recently was flown post-haste to The Dalles, Oregon to pick up a patient. After clearing the field on the return trip, the base station in Portland was contacted for an ambulance to meet the plane at the Troutdale Airfield. The Dalles, Oregon is approximately 90 road miles east of Portland.

The road is a very tortuous winding nightmare. The Troutdale Airfield is approximately 16 road miles east of Portland. The air ambulance and auto ambulance arrived at Troutdale Airport simultaneously, thanks to two-way radio coordination. The considerable saving of time and the greater comfort to the patient may well have been instrumental in saving his life.

REGIONAL DIRECTORY

For your convenience there is listed below a complete directory of Motorola Regional Managers, their offices and territory covered.

REGION 1
HENRY C. GAMMELL
Arizona, California, Idaho, Montana, Nevada, Oregon, Washington, Wyoming, Utah.
Office: 811 South "B" Street
San Mateo, California
Phone: DIAMOND 4-6386

REGION 2
EUGENE F. BROWN
Colorado, Iowa, Kansas, Minnesota, Nebraska, North Dakota, South Dakota.
Office: 817 Kilpatrick Bldg.
Omaha, Nebraska
Phone: WEBSTER 0017

REGION 3
HOMER L. MARRS
Illinois, Indiana, Missouri, Wisconsin.
Office: 1327 W. Washington Blvd.
Chicago, Illinois
Phone: TAYLOR 9-2200

REGION 4
GLENN MUNRO
Kentucky, Michigan, Ohio, Tennessee.
Office: 19142 James Couzens Hwy.
Detroit 35, Michigan
Phone: UNIVERSITY 3-6464

REGION 5
EDWARD L. FALLS, JR.
Arkansas, Louisiana, New Mexico, Oklahoma, Texas.
Office: 6310 Denton Drive
Dallas 19, Texas
Phone: ELMHURST 5311

REGION 6
HORACE E. BOYLAN
Alabama, Florida, Georgia, Mississippi, South Carolina.
Office: Stallings Bldg., Rm. 601
1829 First Ave., North
Birmingham, Alabama
Phone: 4-4582

REGION 7
L. HARRISS ROBINSON
JOHN F. FUSSELL, Asst.
Delaware, Maryland, North Carolina, Virginia, Washington, D.C., West Virginia.
Office: 2309 Calvert St., N.W.
Washington 8, D. C.
Phone: ADAMS 5620

REGION 8
P. R. KENDALL
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont.
Office: 540 Main Street
Winchester, Mass.
Phone: 6-2482

REGION 9
LOWELL E. WHITE
New Jersey, New York, Pennsylvania.
Office: 102 Linwood Plaza
Fort Lee, New Jersey
Phone: 8-9100

Eugene S. Goebel,
National Sales Manager

Henry C. Gammell,
Manager, Region 1

Eugene F. Brown,
Manager, Region 2

Homer L. Marrs,
Manager, Region 3

Glenn Munro,
Manager, Region 4

from the REGIONS....

WE join to extend season's greetings to our many friends among the NEWSGRAM readers.

In 1953, as in past years, the Motorola Radio Communications Engineers will introduce to you further advances in the field of 2-way radio as they are perfected in Motorola's Communications Laboratories . . . . and will assist you in weaving these products into a complete custom-engineered system which meets your particular needs.

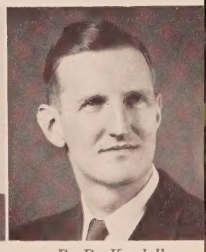
In keeping with Motorola's policy of "service-after-sale", we shall continue to assist you in the maintenance of your equipment, making certain that it fulfills every job which it was intended to perform.

Motorola's success in this field is, to a large degree, attributable to the recognition of the value of satisfied customers—the people who return to favor us with their business as their own operations grow. We know that you have a job to do. Our efforts are directed toward helping you do your job in the most efficient and modern manner possible.

Edward L. Falls, Jr.,
Manager, Region 5

Horace E. Boylan,
Manager, Region 6

John F. Fussell,
Asst. Manager, Region 7



P. R. Kendall,
Manager, Region 8

Lowell E. White,
Manager, Region 9

Fred H. Schnell,
National Service Manager

John Jipp,
West Coast Service Mgr.

L. Harriss Robinson,
Manager, Region 7

Floyd McCall,
Railroad Sales Manager

Motorola

Closes the Curtain on 1952 . . . And heads toward 1953

In the Field of Electronics, the solution of customer application problems through the exercise of ingenuity, and by the use of extraordinary scientific know-how, balanced by the discipline of economic limitations, flavored by the pride of accomplishment, and by a zest for quality performance, produces a most gratifying sense of accomplishment.

1952

The personal satisfaction I derive from successful service to our customers is balanced only by the distress I experience when field faults are discovered. Fortunately, the words of praise from customers well satisfied always over-balance the complaints. While the words of praise add immeasurably to the joy of our work, the complaints are essential to the progress of our organization. Praise makes life worth living; complaints make future praise possible.

In industry, the challenge of successful "applied science" cannot be fulfilled without customer participation. No engineer is smart enough to design a perfect piece of equipment to fit customer needs without failures, flaws or inadequacies. The customer is the agent of discipline, the measurer of success, the critic of performance, and the final authority on the validity and the practicability of the solution to his problem. To the extent to which customer experience with equipment is fed back to the design engineers, progress will be made in a continual effort to eliminate flaws, improve reliability and extend performance. The feedback principle in customer relationships is an essential requirement.

All Motorola men are ordered to keep the feedback loop from engineering to production, to customer, back to engineering in a high state of activity. Every field report of failure, limitation, or substandard performance receives sharp and worried attention until tests either establish the fault as an exception or result in a design change to yield permanent improvement.

Motorola pledges vigorous support of the feedback principle, toward the end that there shall be continual improvement in equipment performance and reliability, and in the application of specialized engineering knowledge to the economic and practical solution of customer application problems. Success is the accolade bestowed by our customers; we shall earn it by our sincerity of purpose in serving our customers' best interests.

Dan Noble

1953